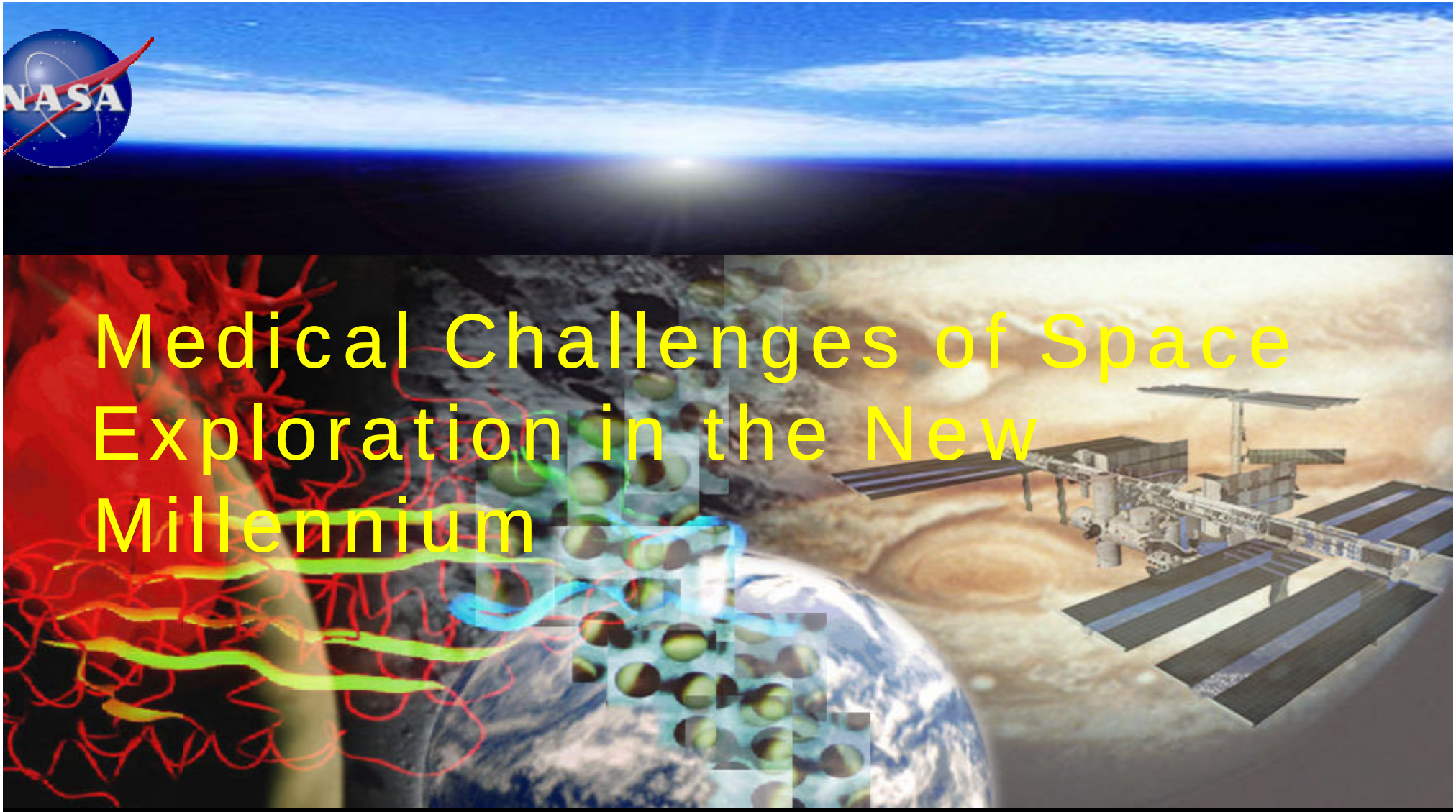

Medical Challenges of Space Exploration in the New Millennium

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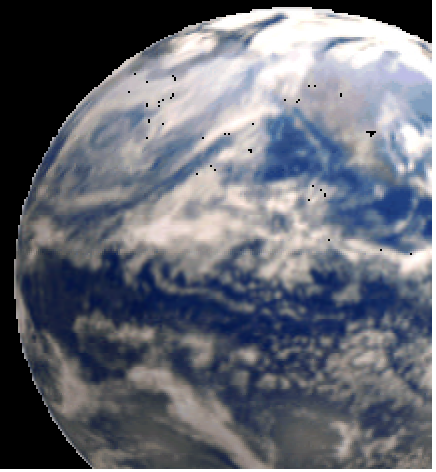
NASA Office of Life & Microgravity Sciences & Applications

NASA Vision

NASA is an investment in America's future.

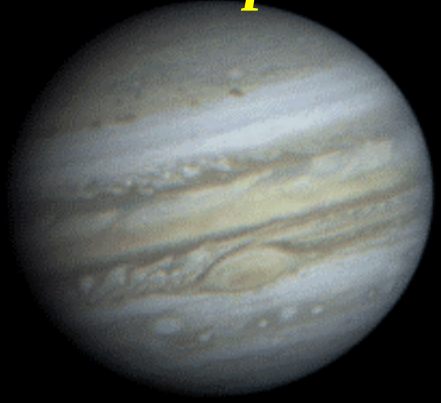
As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.



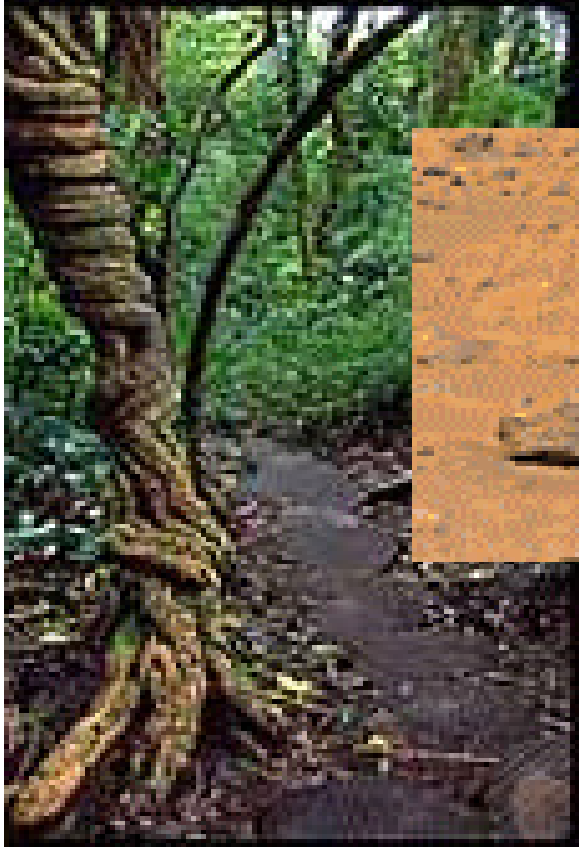
The Extremes of the Space Environment

Eros

Jupiter

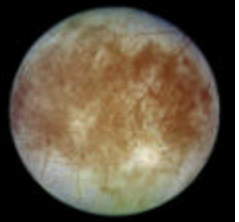


Earth



Mars

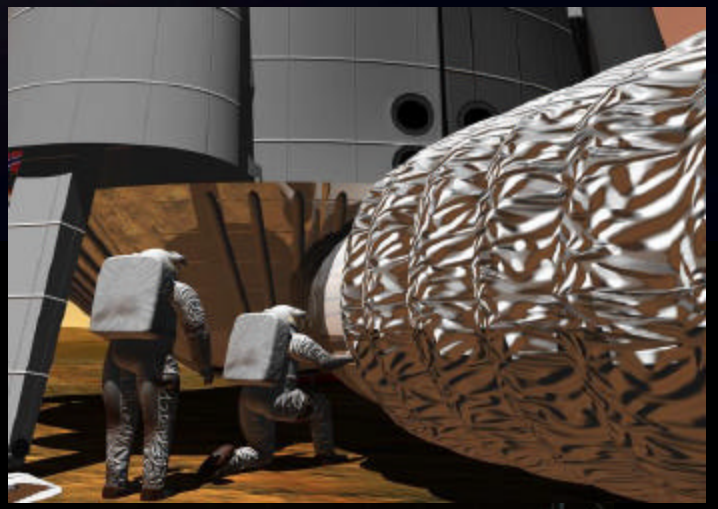
Europa



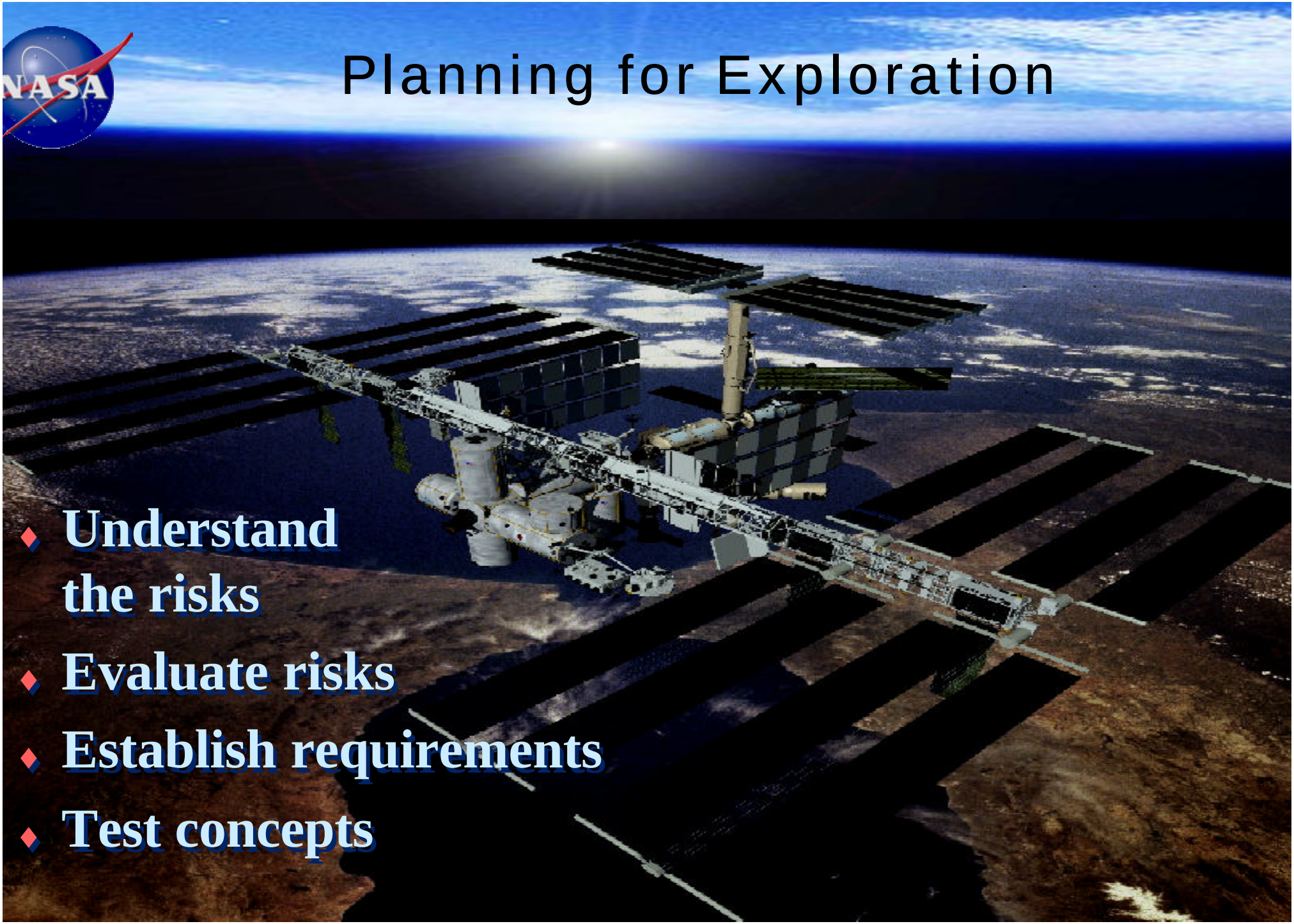
Moon

Human Potential in Space

- Explore the Solar System
- Deploy outposts
- Establish settlements
- Look for signs of life



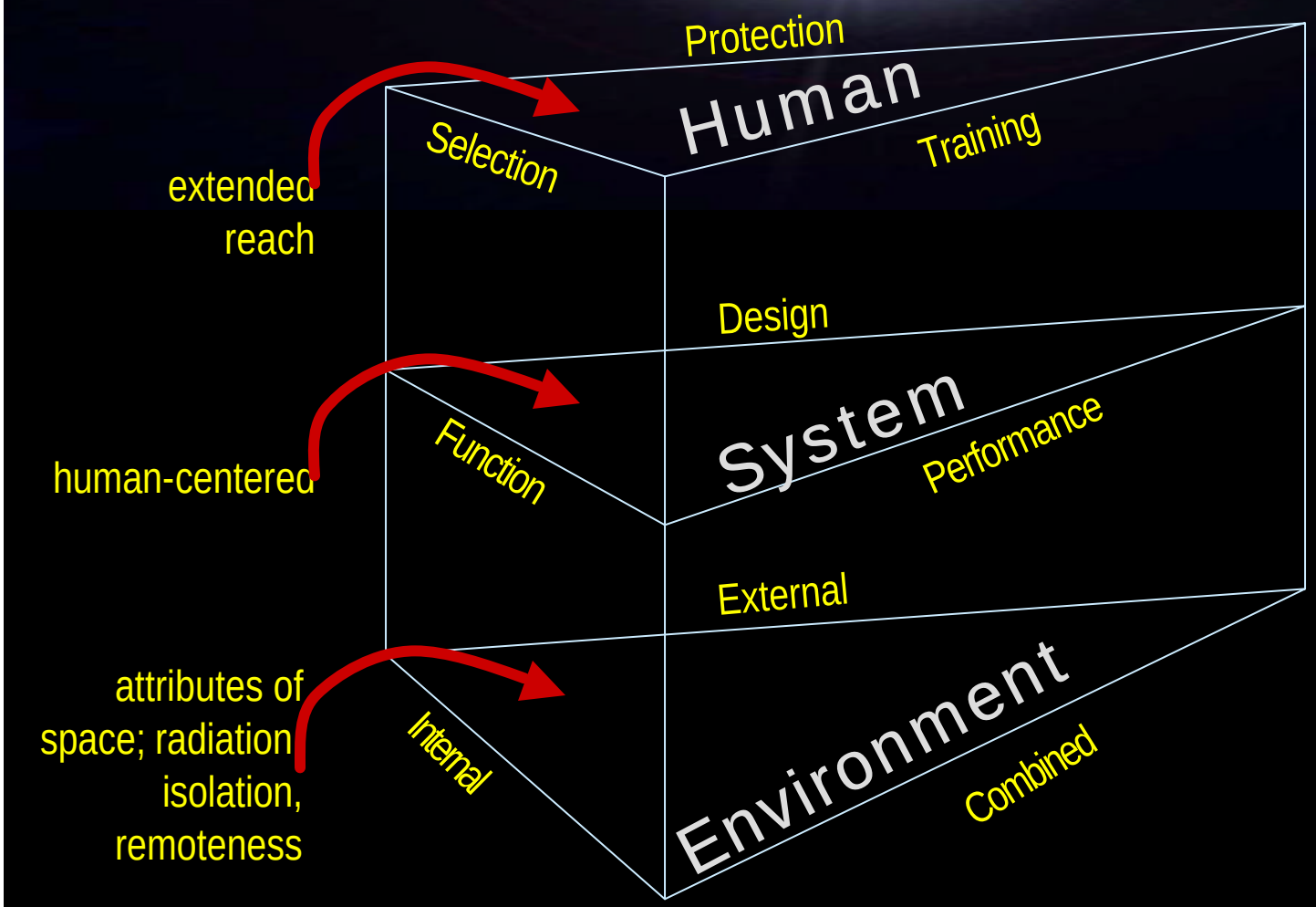
Planning for Exploration



- Understand the risks
- Evaluate risks
- Establish requirements
- Test concepts

Mission Success

Human
System
Environment



Designers must facilitate Human performance…

…by creating a System that responds effectively…

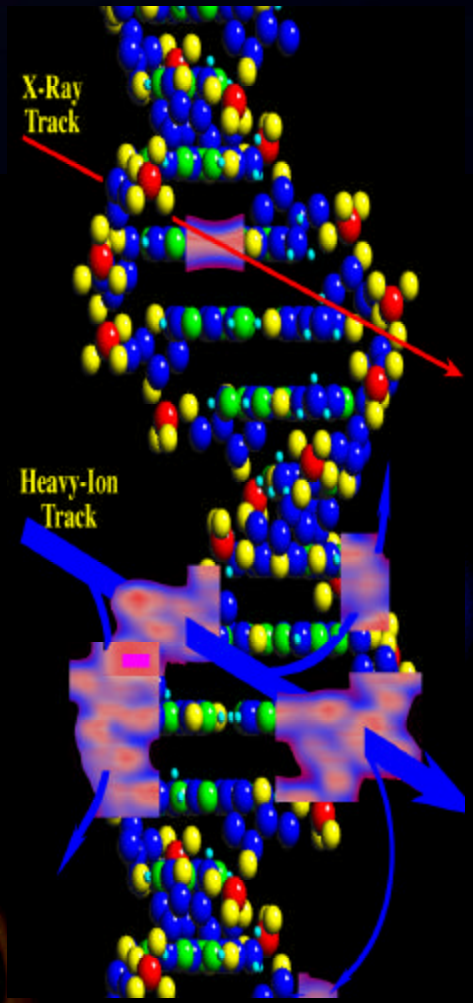
…to the challenges of the space flight Environment.

Environment

- Microgravity
- Radiation
- Temperature extremes
- Intolerable pressures
- Biological threat?
- Time/distance
- Collision threat
- Isolation
- Confinement

Convection
Buoyancy
Sedimentation

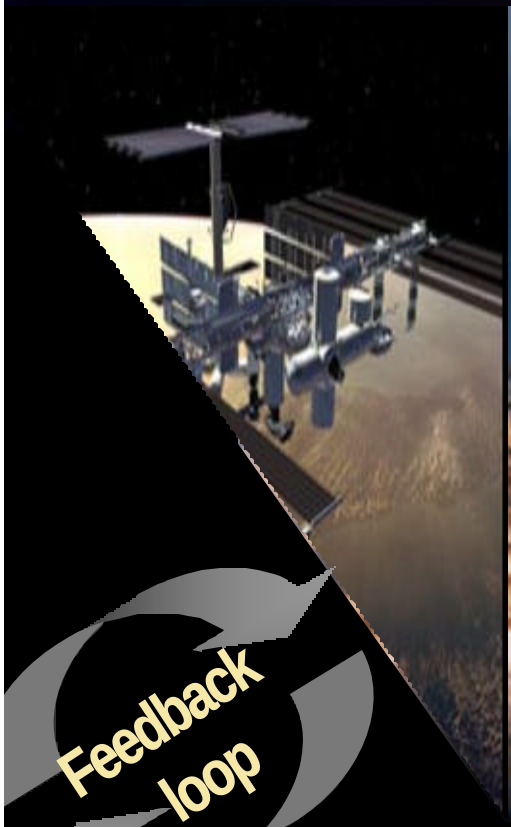
Human System Environment



System

Human
System
Environment

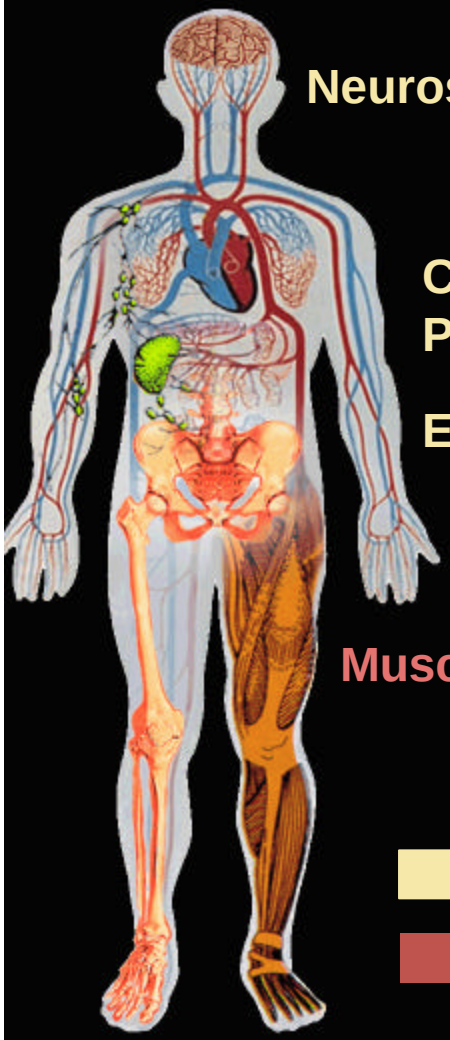
Function → **Performance**



Feedback loop

Design

Human in Spaceflight



Neurosensory & Neuromotor

Cardiovascular/
Pulmonary

Endocrine

Musculoskeletal

Adaptive

Pathological

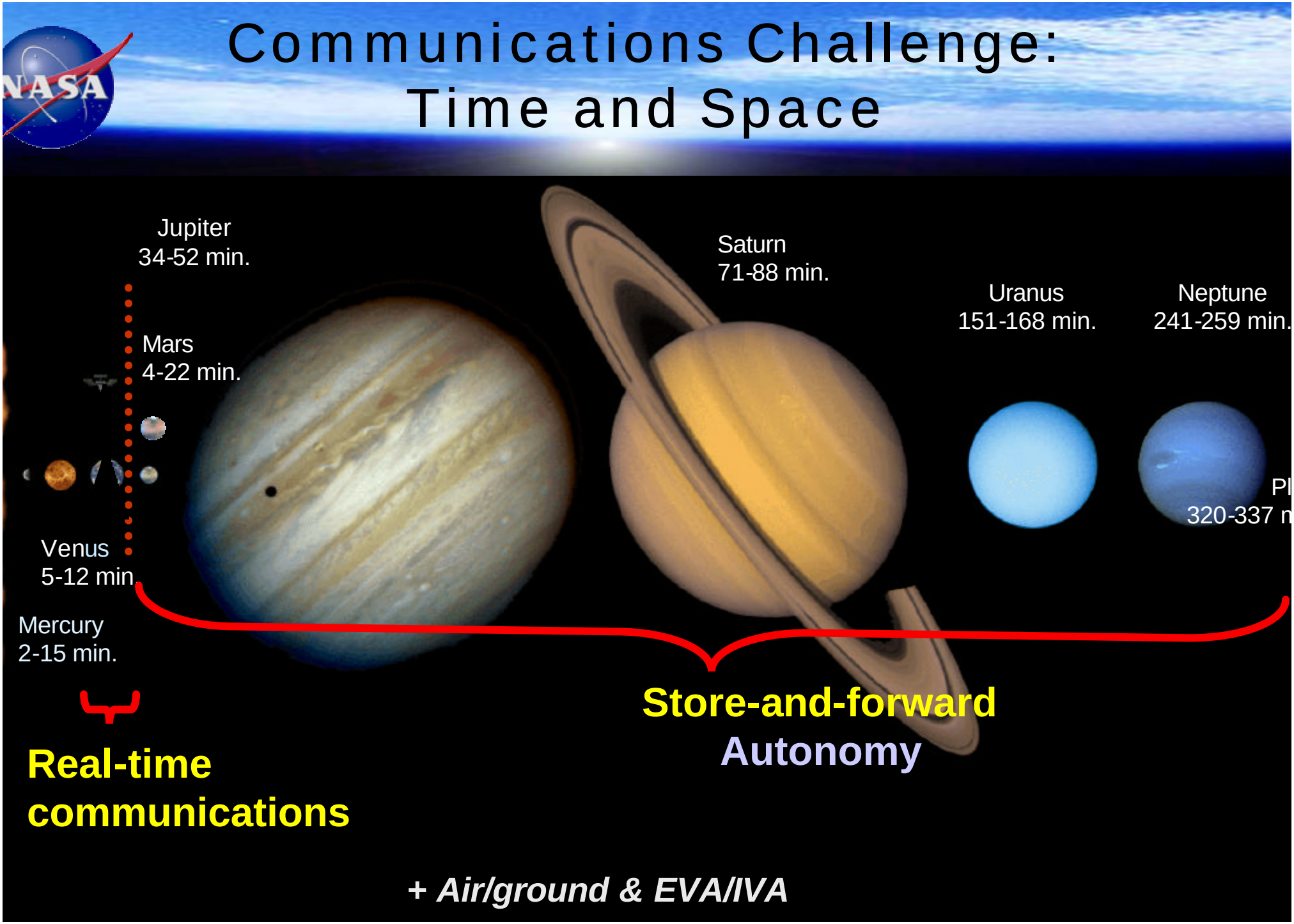
Confinement

Radiation

Address human needs through

- Crew selection
- Crew training
- Countermeasures
- System configuration
  - ✓ *Ergonomics*
  - ✓ *Adaptive interfaces*
  - ✓ *Privacy*
  - ✓ *Recreation*

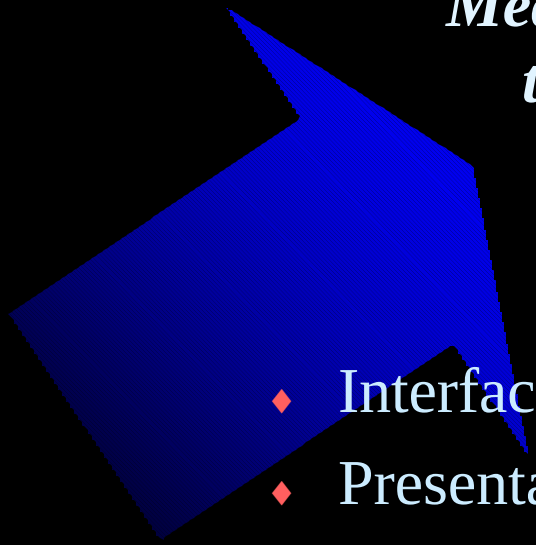
Communications Challenge: Time and Space



Health Care Needs Beyond LEO

The remoteness of exploration-class missions generates a unique set of requirements for health care systems

- Compact
- Lightweight
- Portable
- Low maintenance
- Easy-to-use
- Autonomous
- Minimally invasive

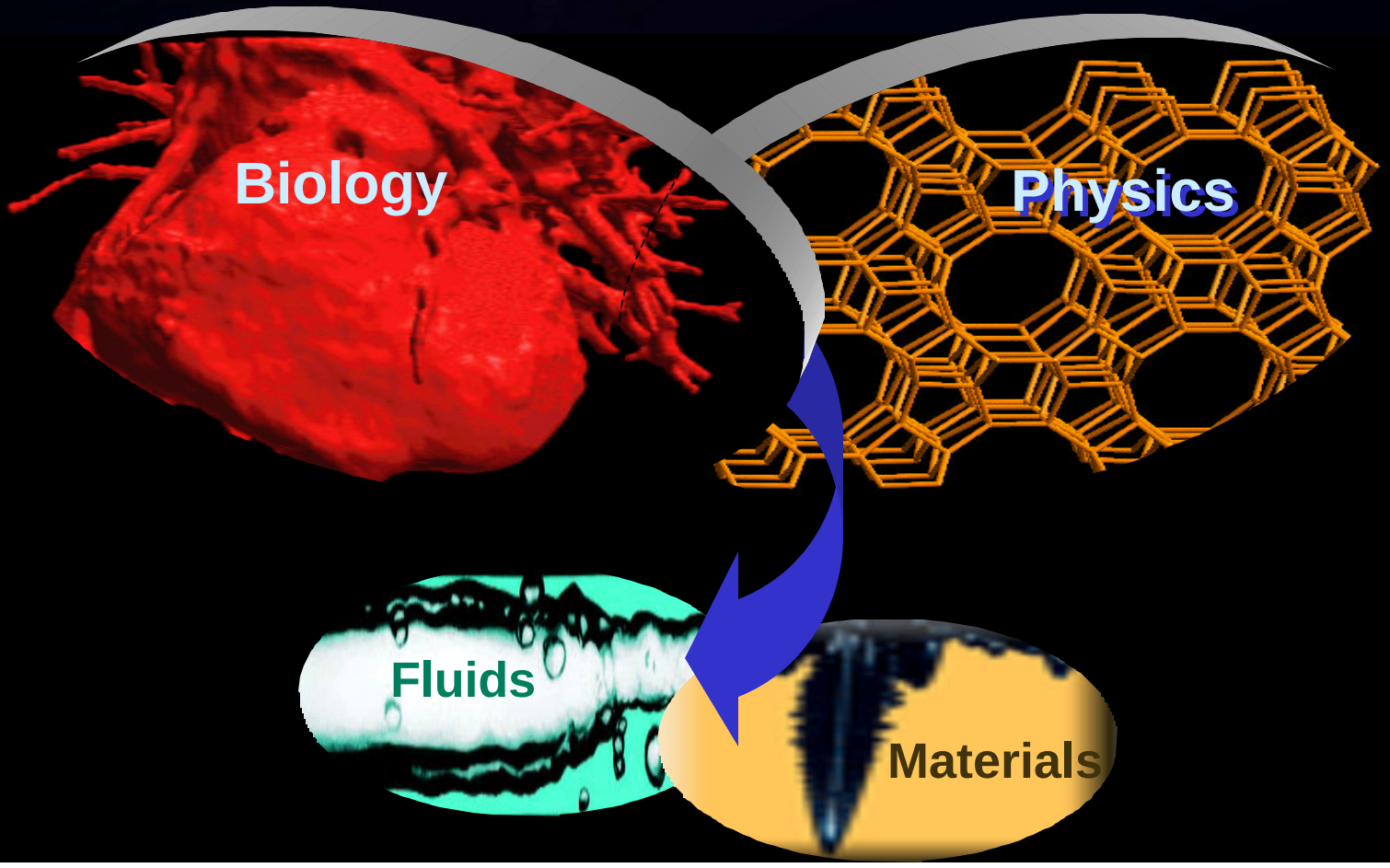


Medical informatics is the cross-cutting technology

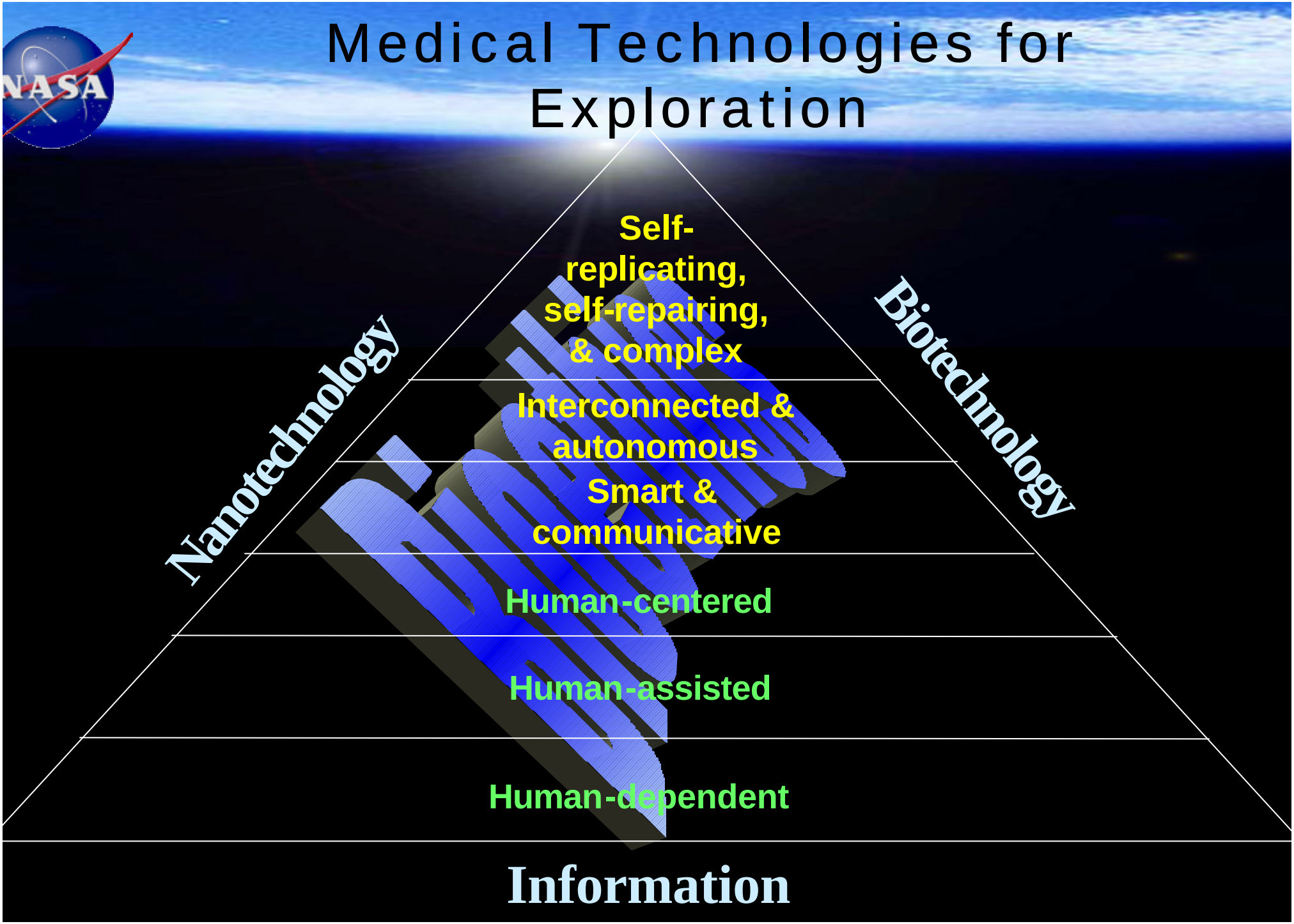
- Interface capability
- Presentational/display versatility
- Flexibility
- Computational power

Interdisciplinary Approach

...Processes...



Medical Technologies for Exploration



Bioastronautics

Living and working in space

- Habitation
- Adaptation/Prevention

Medicine in extreme environments

- Health care systems
- Skills/Training
- Practice standards

Next Steps: Testbeds

Analogs

- Bioplex (life support)
- Extreme environments on Earth
- International Space Station